The Effect of Atlantic SST anomalies on the summer rainfall in East Asia

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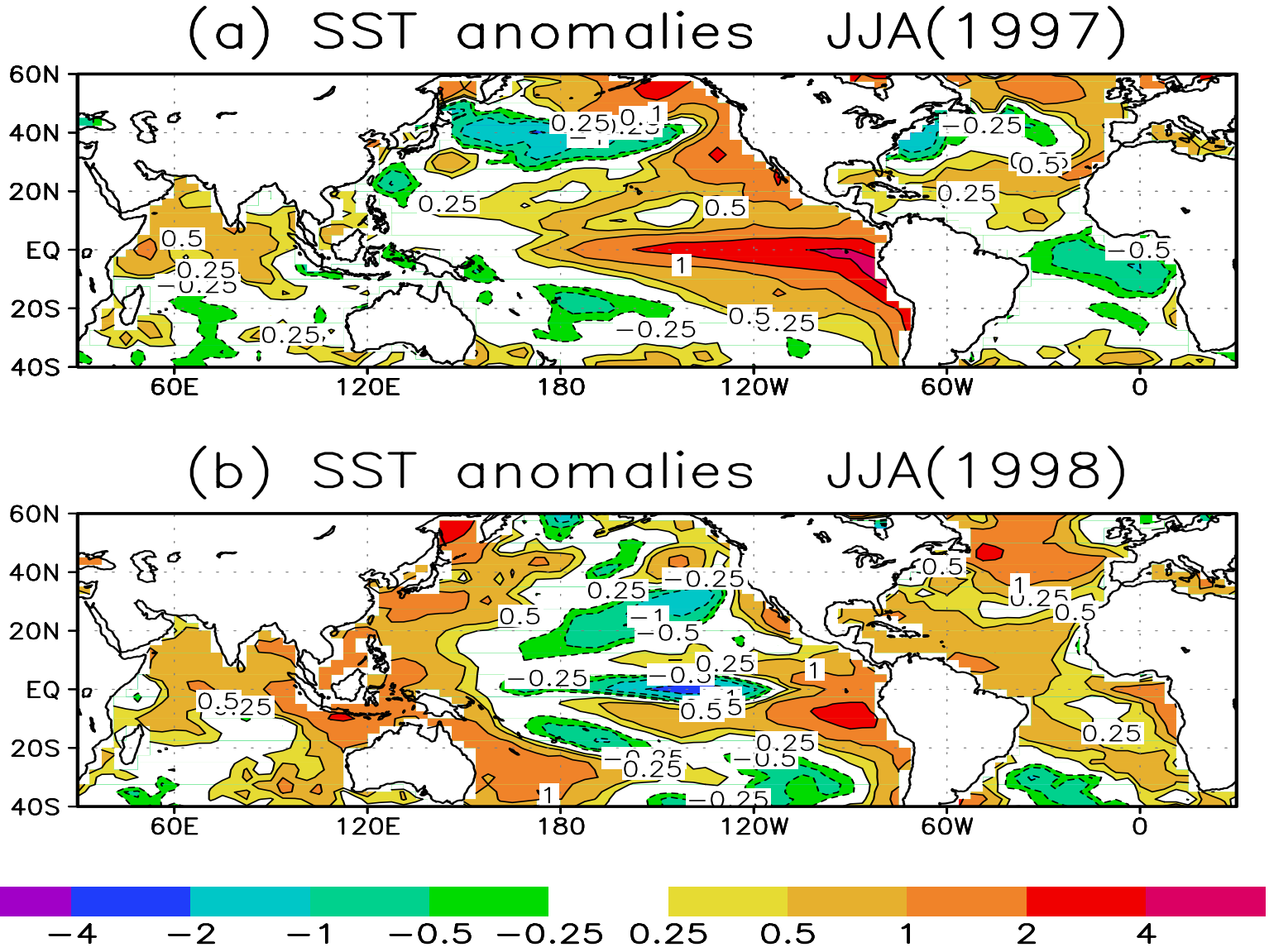
CONTENTS

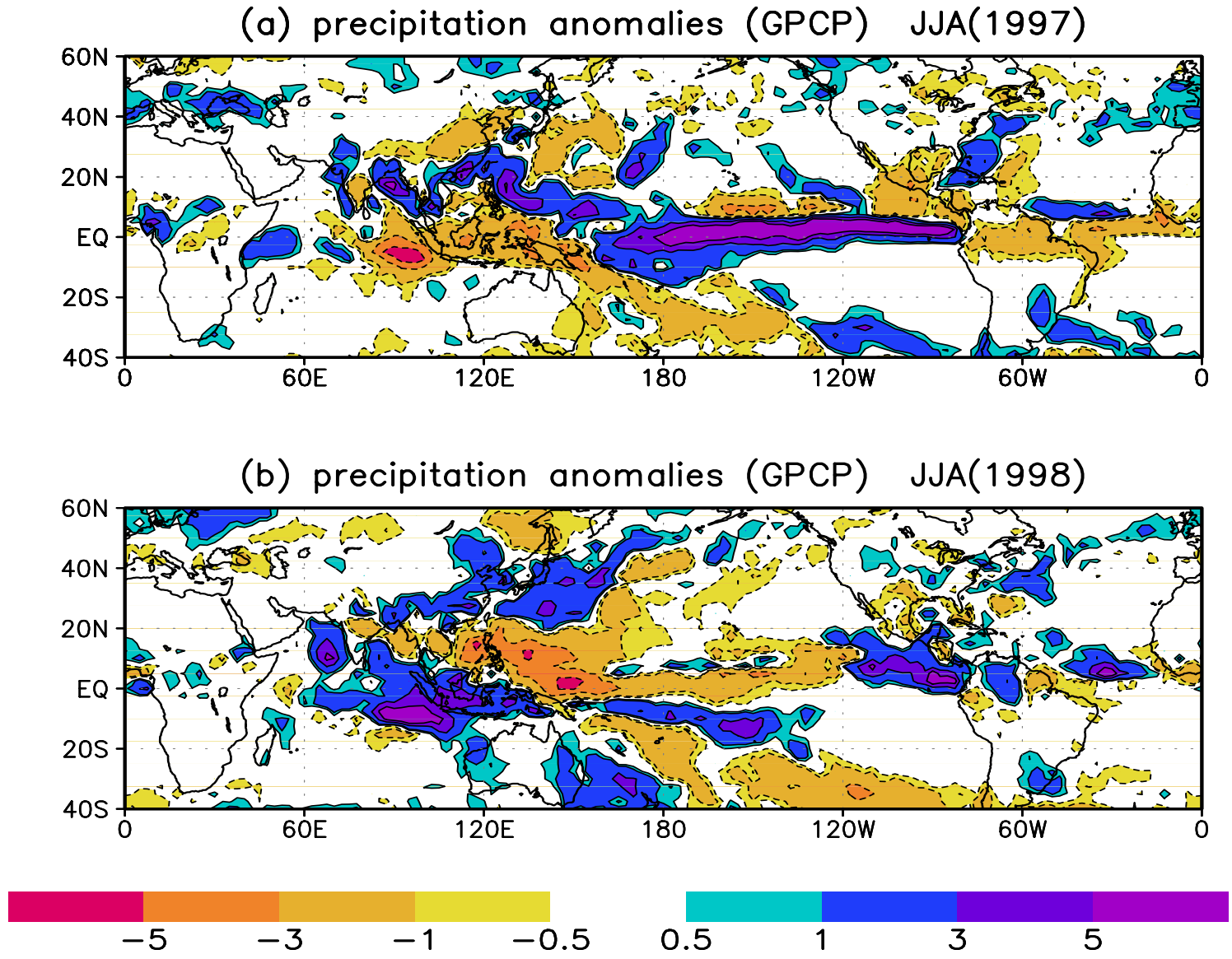
- Observational evidence
- Evaluation of global SST forcing
- Effects of the Atlantic SST anomalies
- Mechanism
- Conclusions

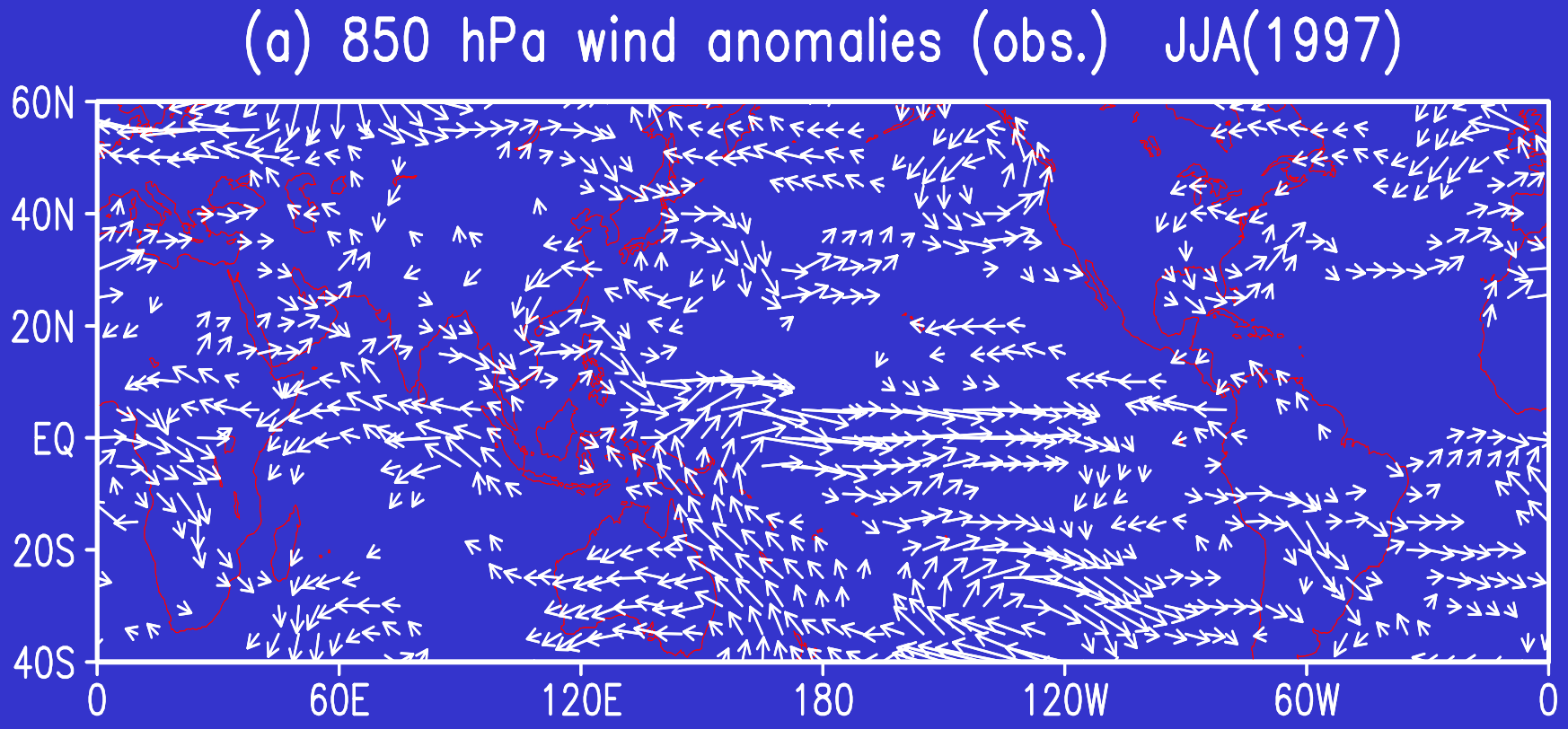
MOTIVATION

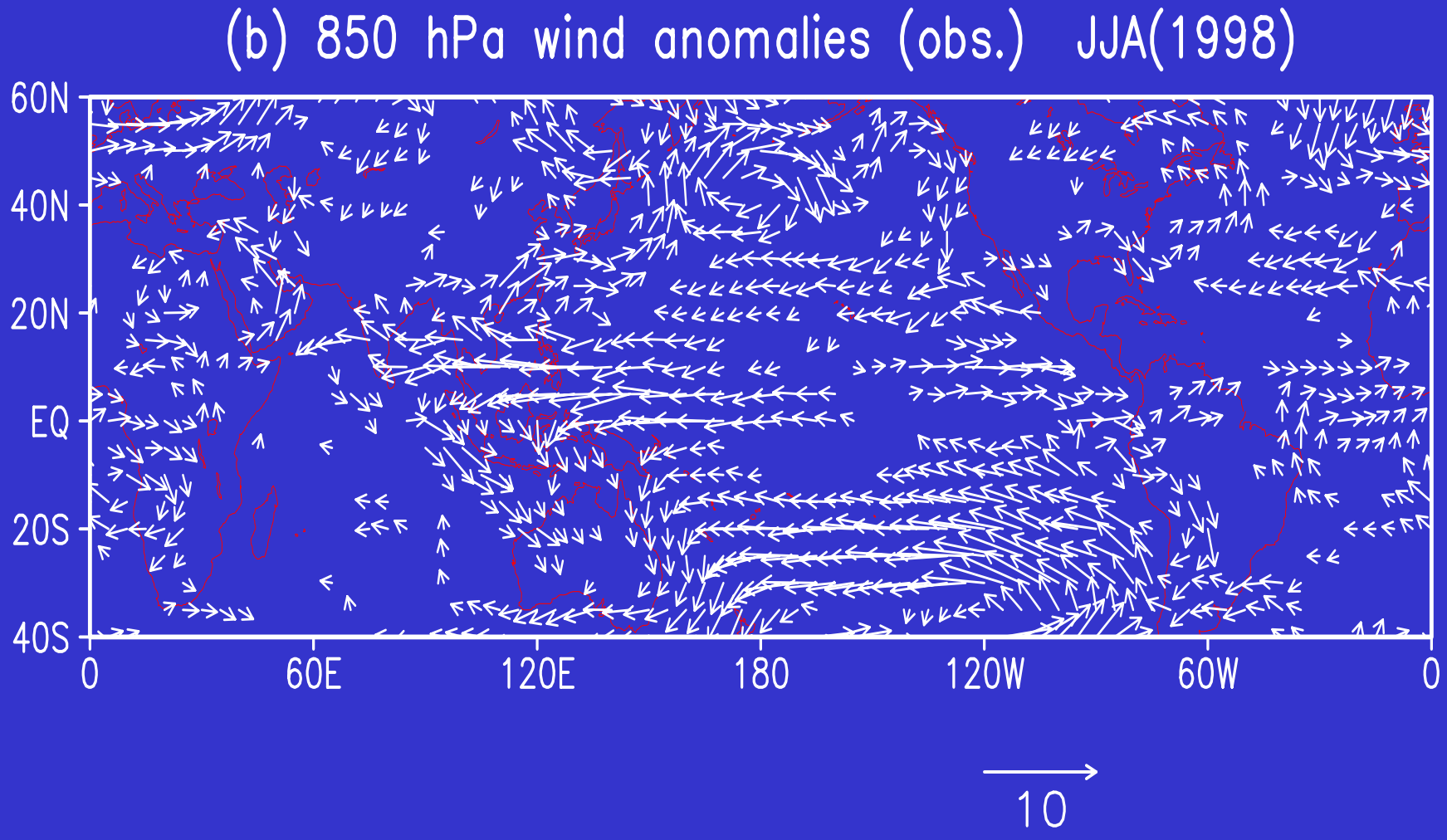
Regarding the effects of the SST anomalies on rainfall anomalies in East Asia

- Pacific: Many studies
- Indian Ocean: Some studies
- Atlantic: ?


(a) SST anomalies JJA(1997)
60N
40N
20N
EQ
20S
40S
60E
120E
180
120W
60W
0
(b) SST anomalies JJA(1998)
−4
−2
−1
−0.5
−0.25
0.25
0.5
1
2
4


(a) precipitation anomalies (GPCP) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(b) precipitation anomalies (GPCP) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
−5
−3
−1
−0.5
0.5
1
3
5


(a) 850 hPa wind anomalies (obs.) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0


(b) 850 hPa wind anomalies (obs.) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
10

Model used

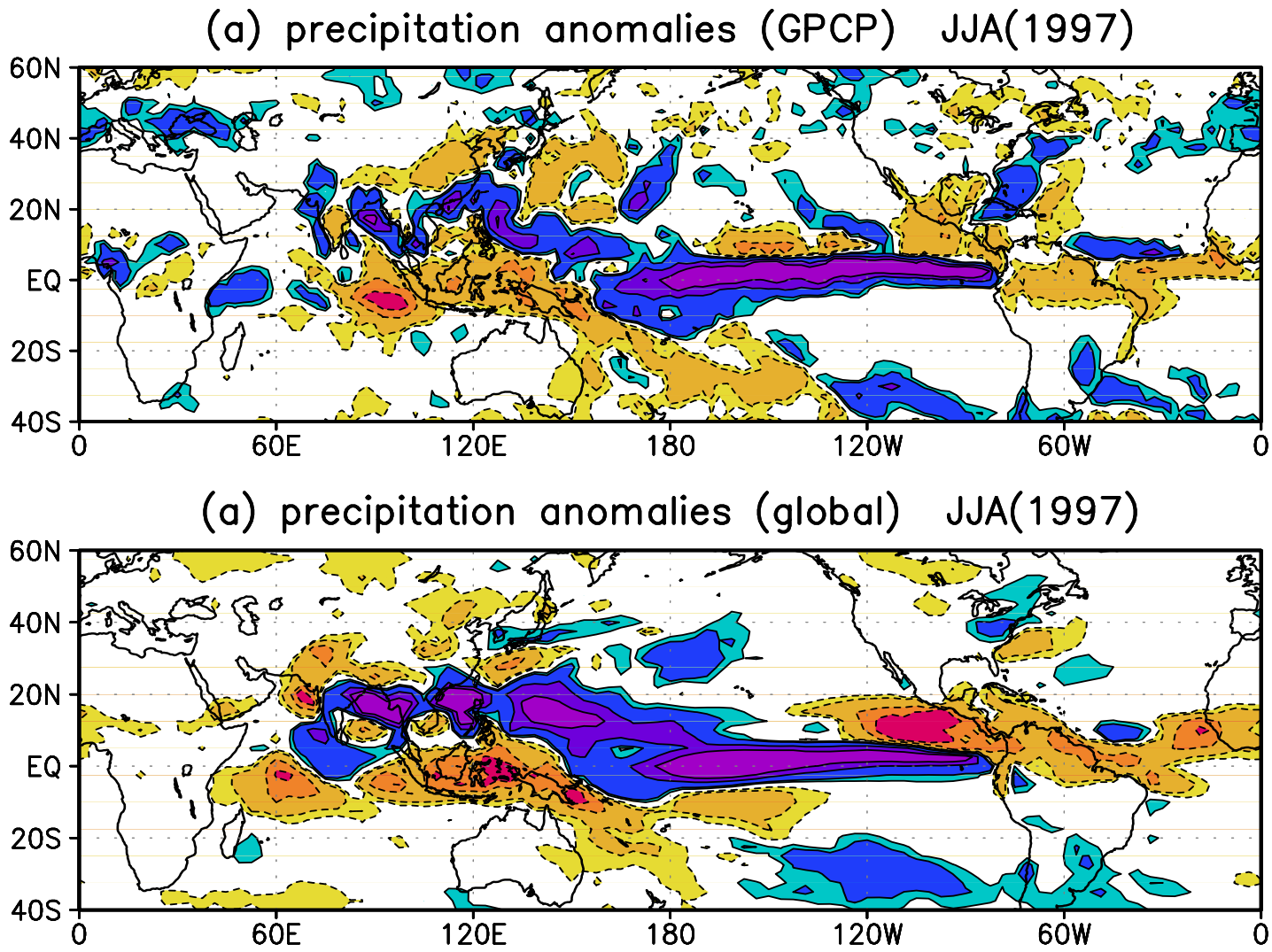
The model used: Hadley Centre model (HadAM3) 2.5º by 3.75º 19 levels.

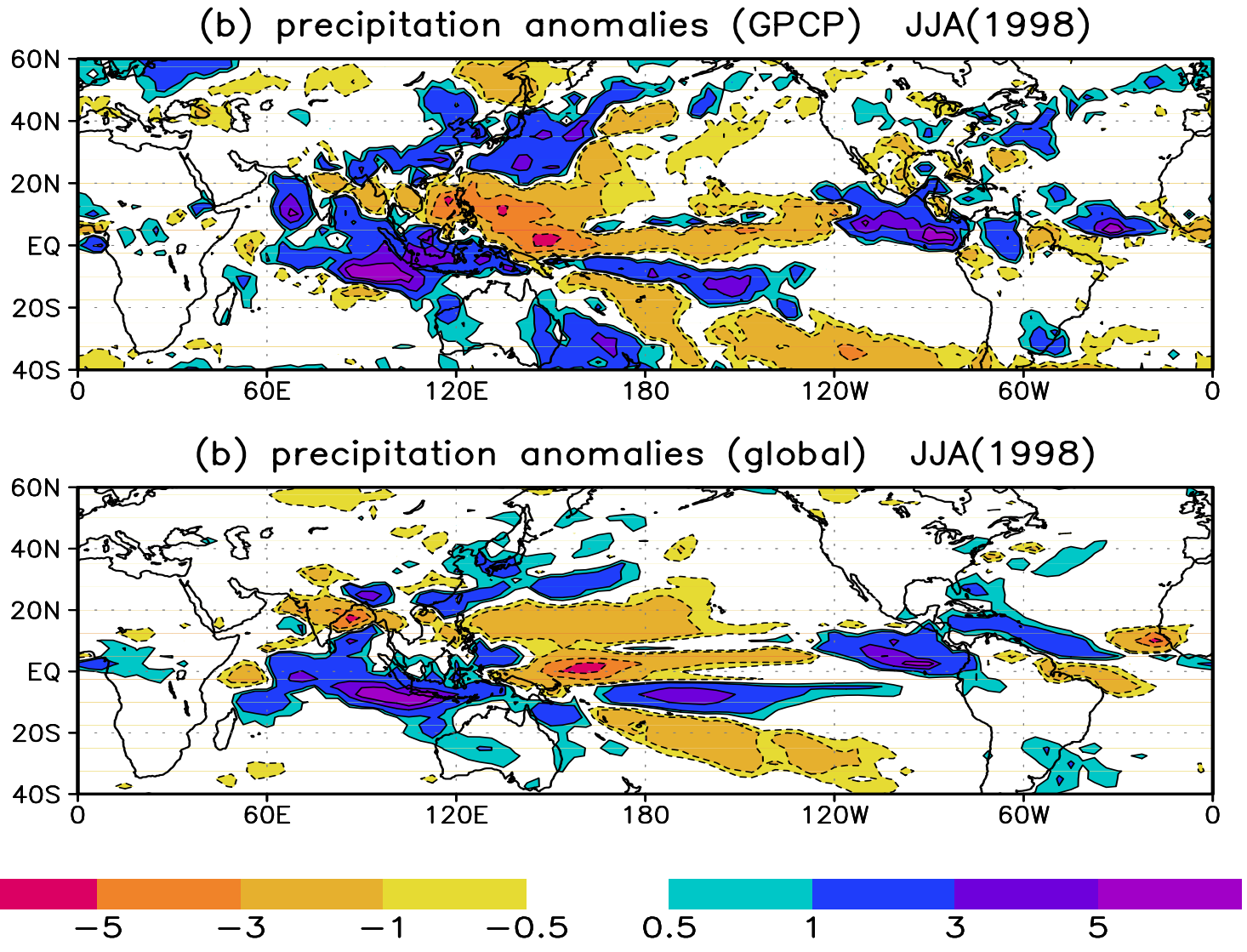
The global experiment: forced with global observed SSTs.

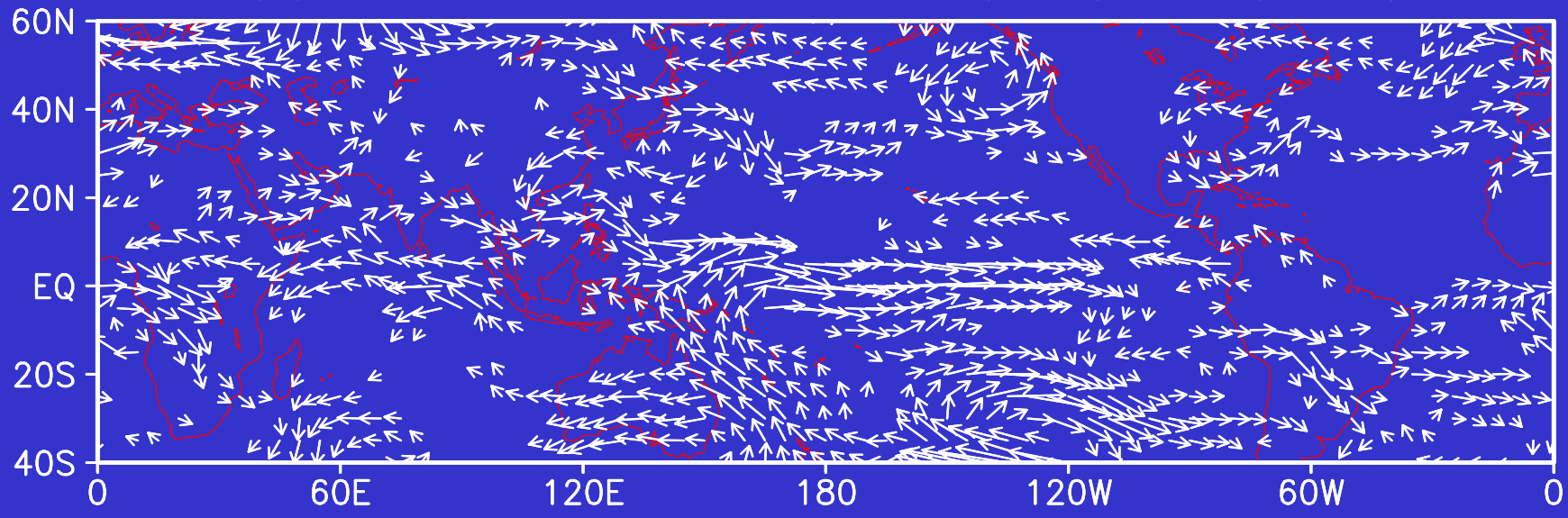
The "without Atlantic" experiment: forced with observed SSTs except in the Atlantic (latitude band 30ºS-75ºN) where the climatological SSTs were used.

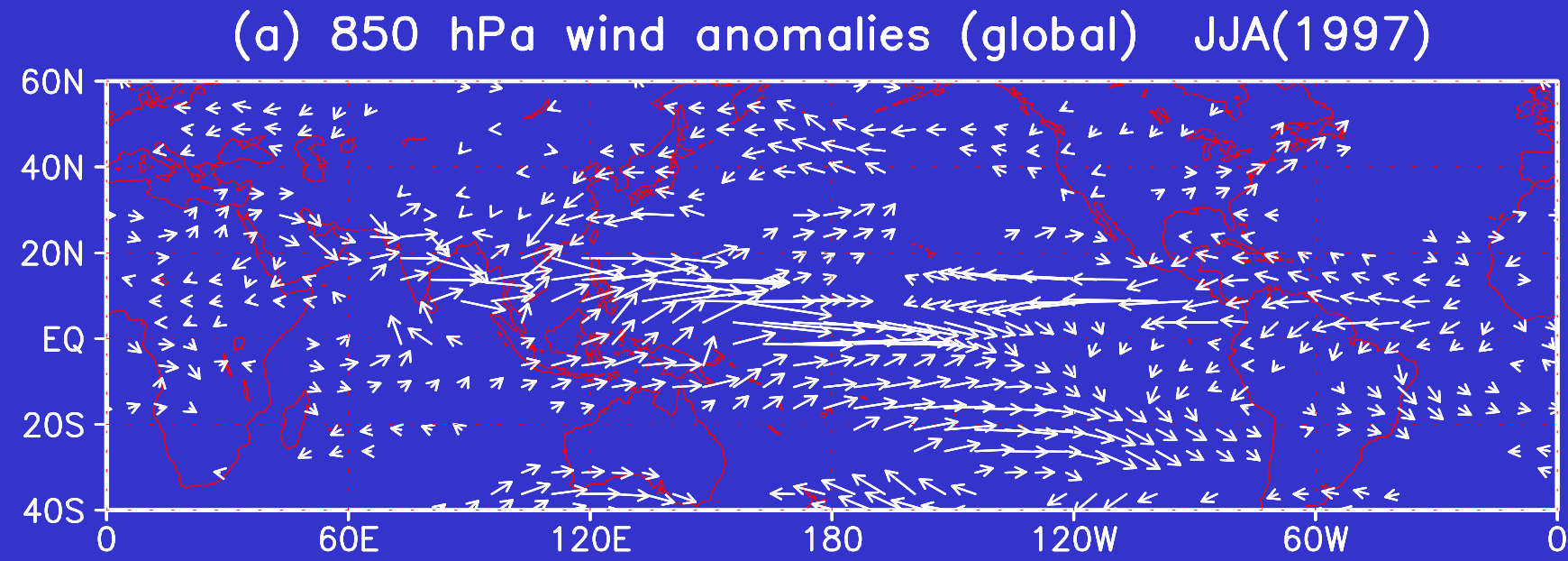
The Atlantic experiment: "Global" – "without Atlantic".

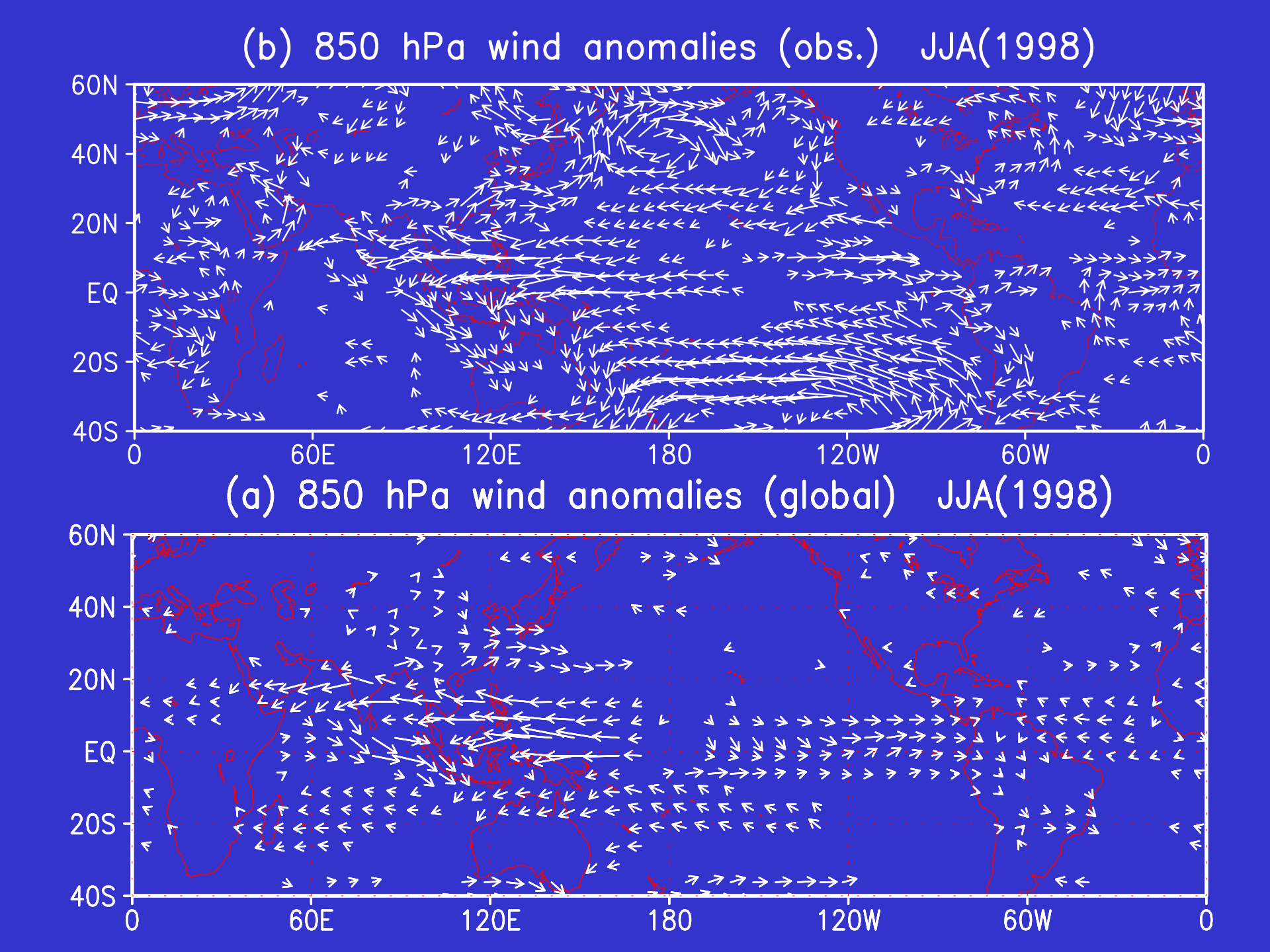
Evaluation of global SST forcing in summers of 1997 and 1998


(a) precipitation anomalies (GPCP) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(a) precipitation anomalies (global) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0

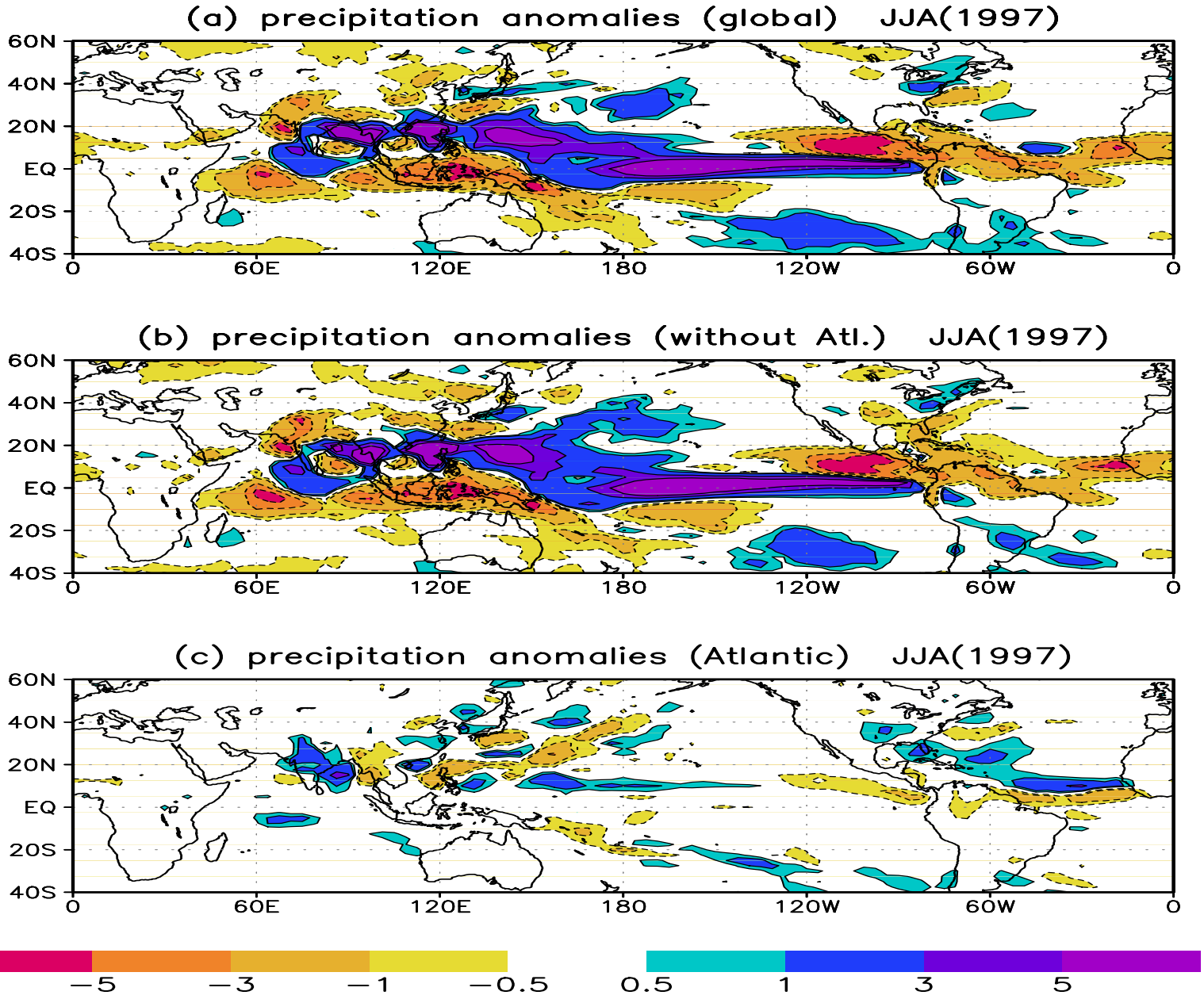

(b) precipitation anomalies (GPCP) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(b) precipitation anomalies (global) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
−5
−3
−1
−0.5
0.5
1
3
5

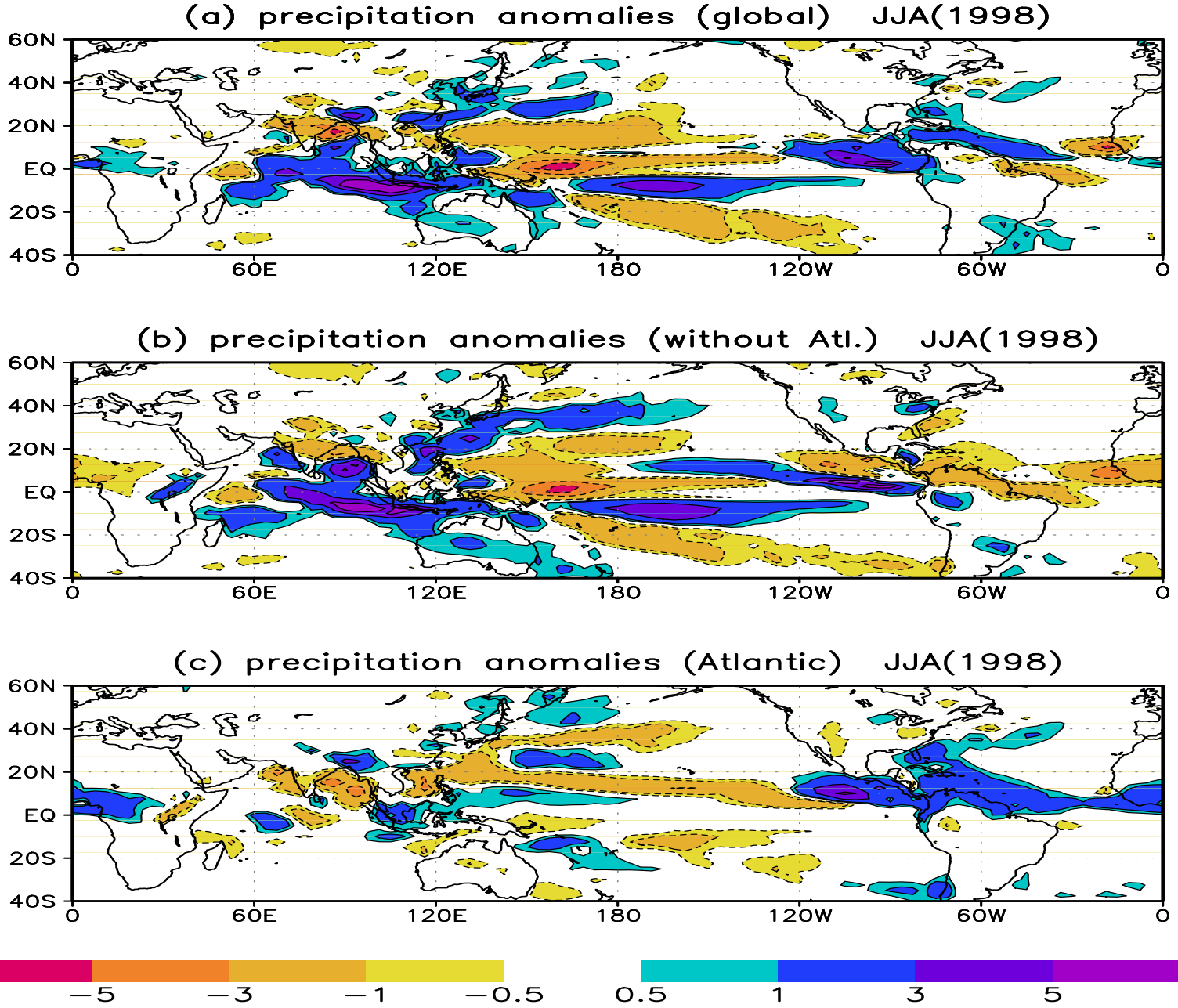

(a) 850 hPa wind anomalies (obs.) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0

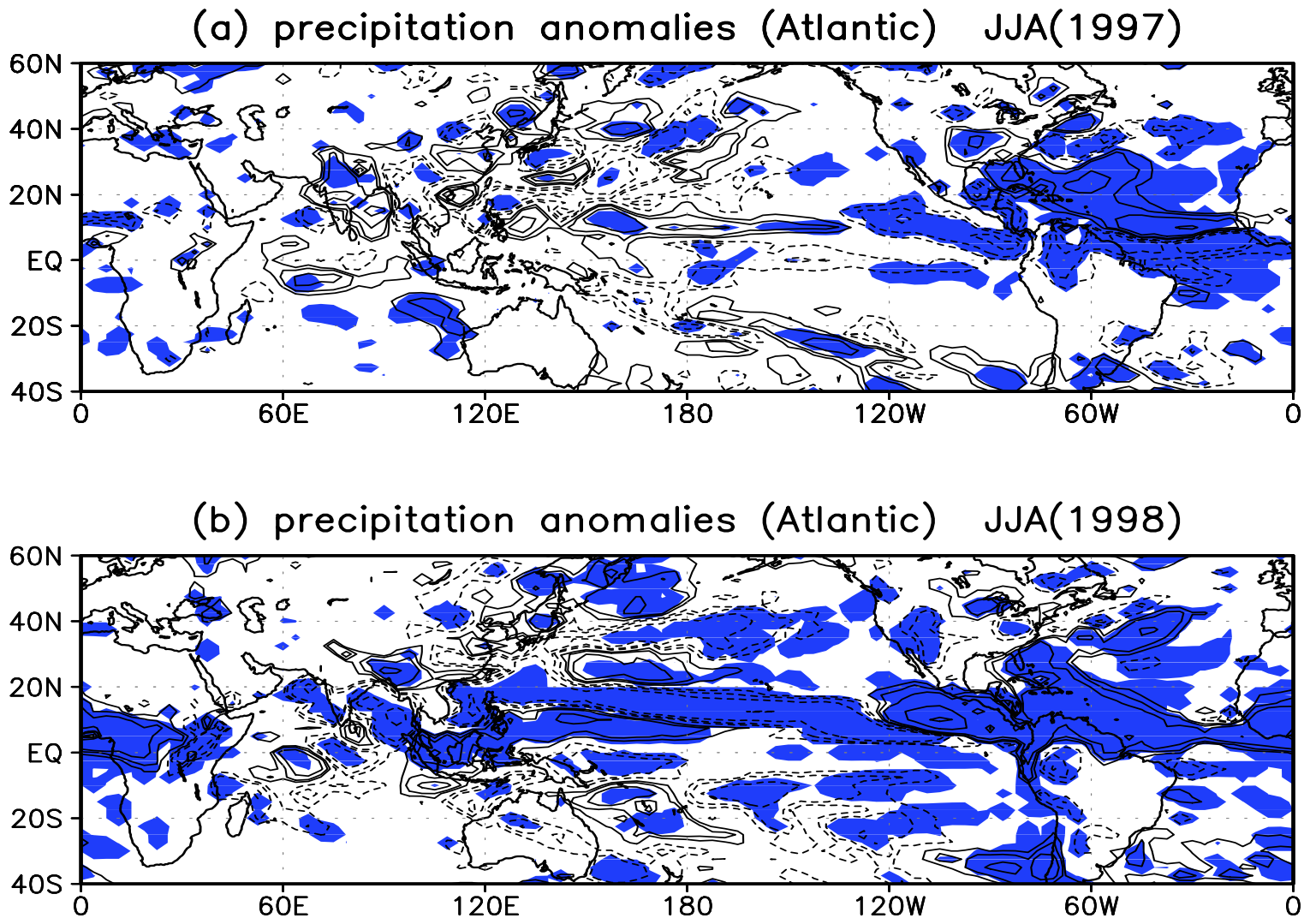

(a) 850 hPa wind anomalies (global) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0

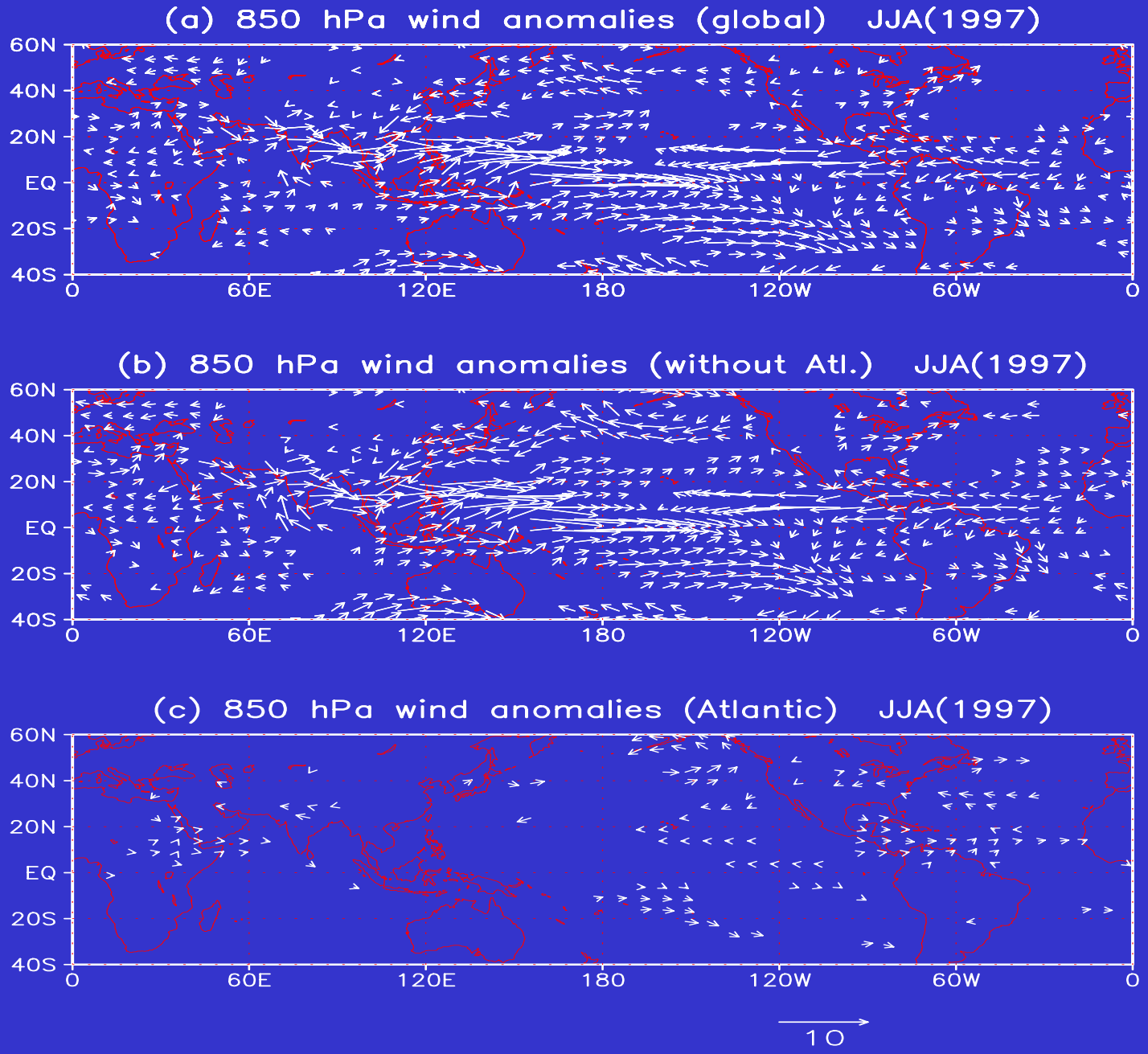

(b) 850 hPa wind anomalies (obs.) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(a) 850 hPa wind anomalies (global) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0

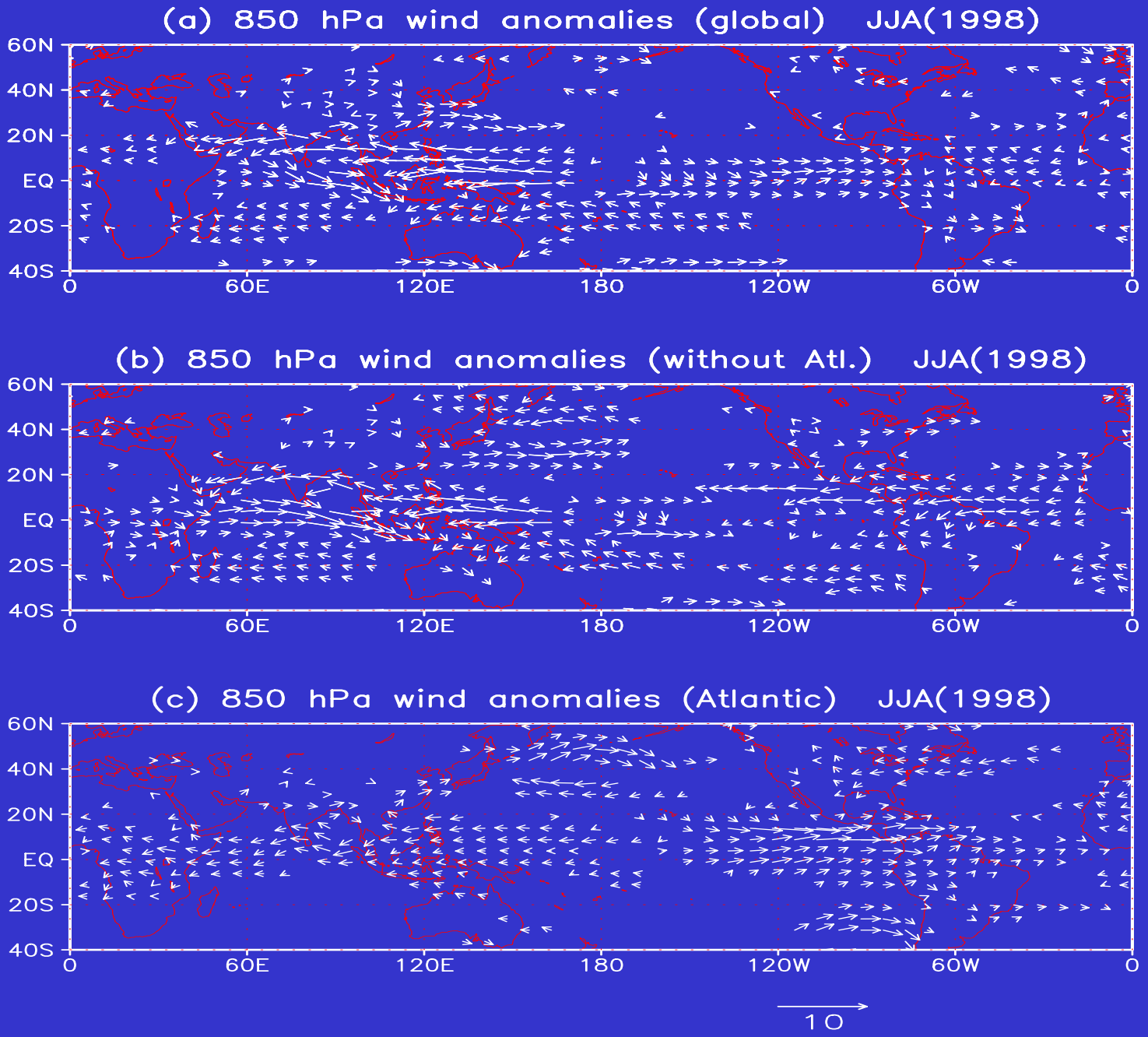
Effects of the Atlantic SST anomalies in summers of 1997 and 1998


(a) precipitation anomalies (global) JJA(1997)
(b) precipitation anomalies (without Atl.) JJA(1997)
(c) precipitation anomalies (Atlantic) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
−5
−3
−1
−0.5
0.5
1
3
5

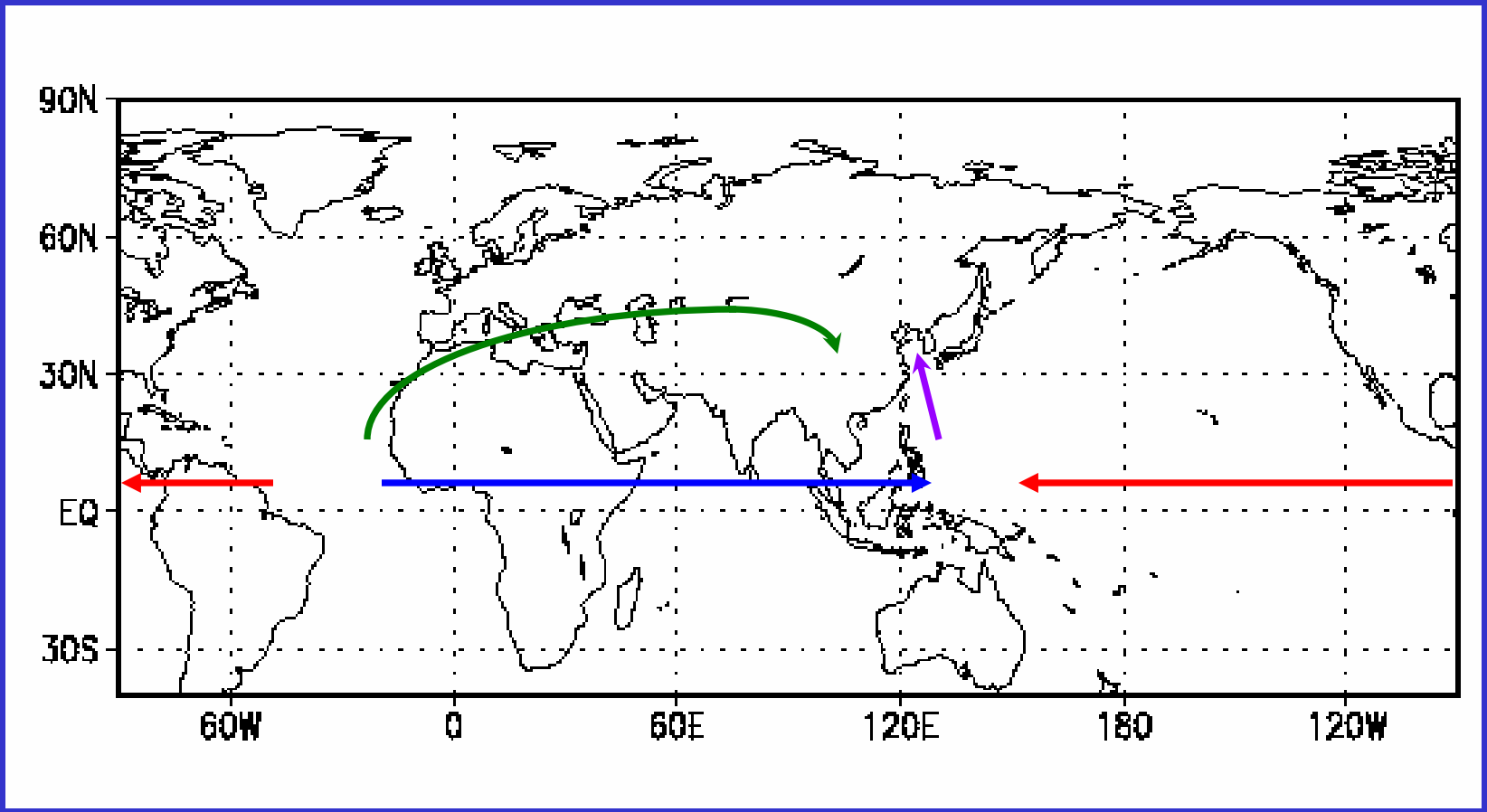

(a) precipitation anomalies (global) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(b) precipitation anomalies (without Atl.) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(c) precipitation anomalies (Atlantic) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
−5
−3
−1
−0.5
0.5
1
3
5

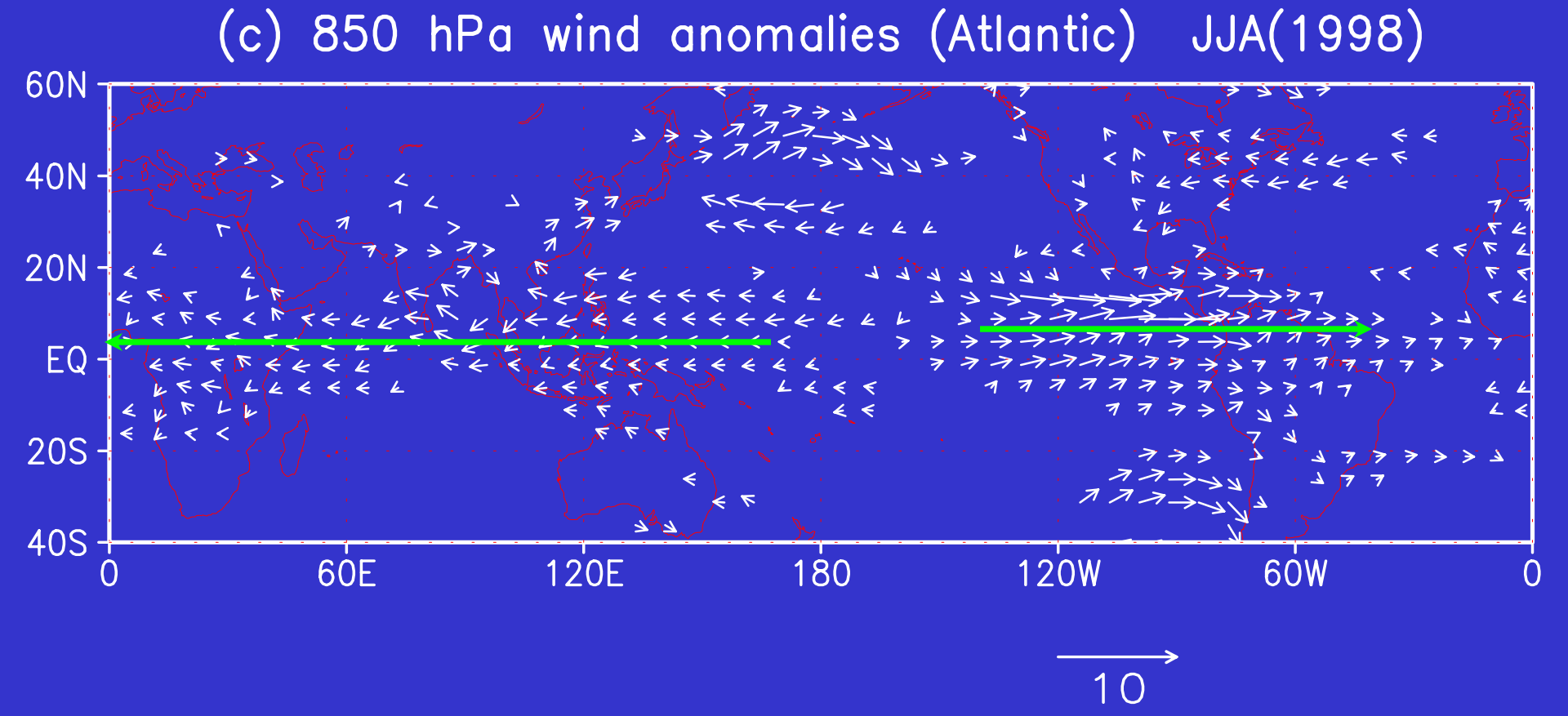

(a) precipitation anomalies (Atlantic) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(b) precipitation anomalies (Atlantic) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0

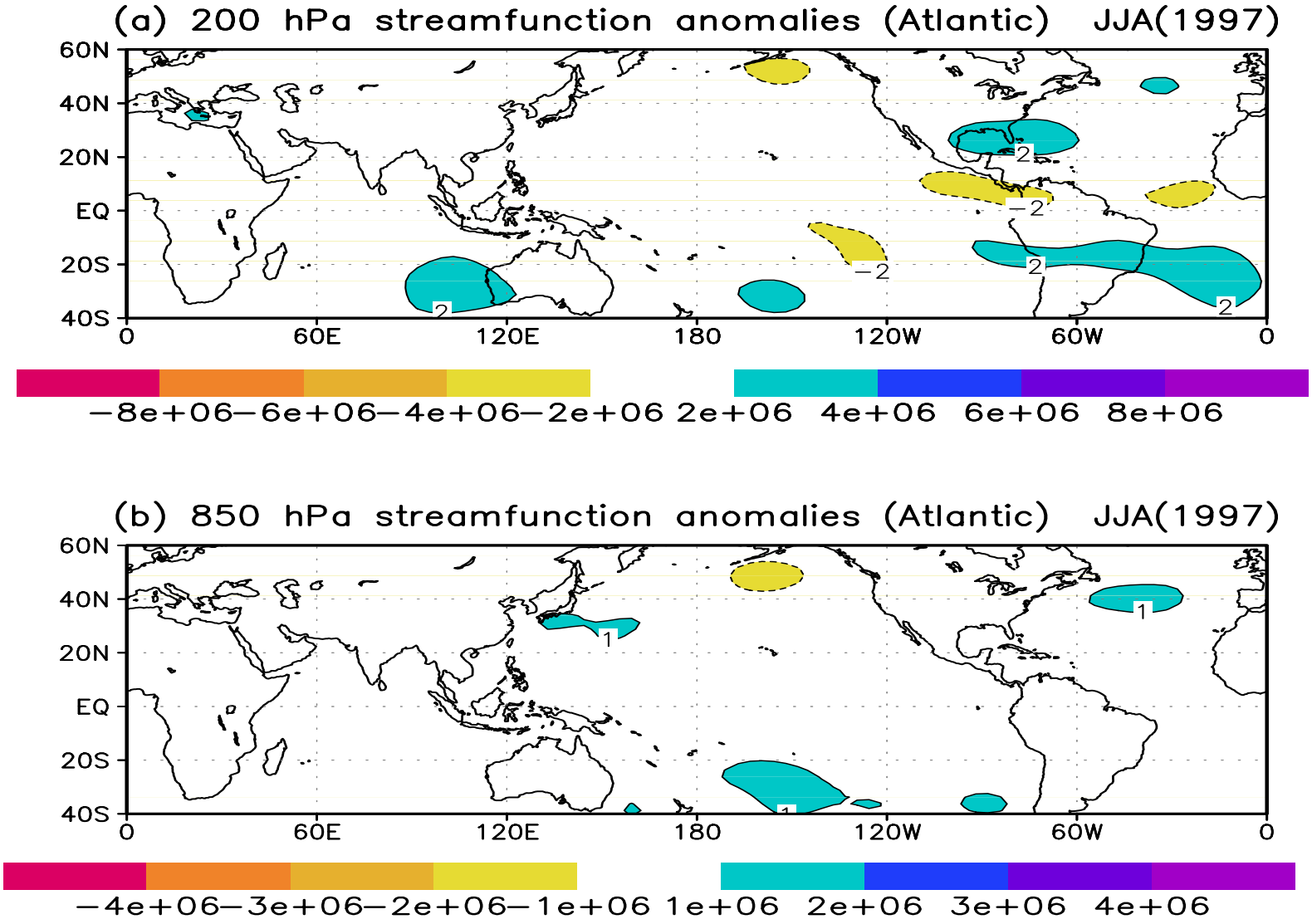

(a) 850 hPa wind anomalies (global) JJA(1997)
(b) 850 hPa wind anomalies (without Atl.) JJA(1997)
(c) 850 hPa wind anomalies (Atlantic) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
10

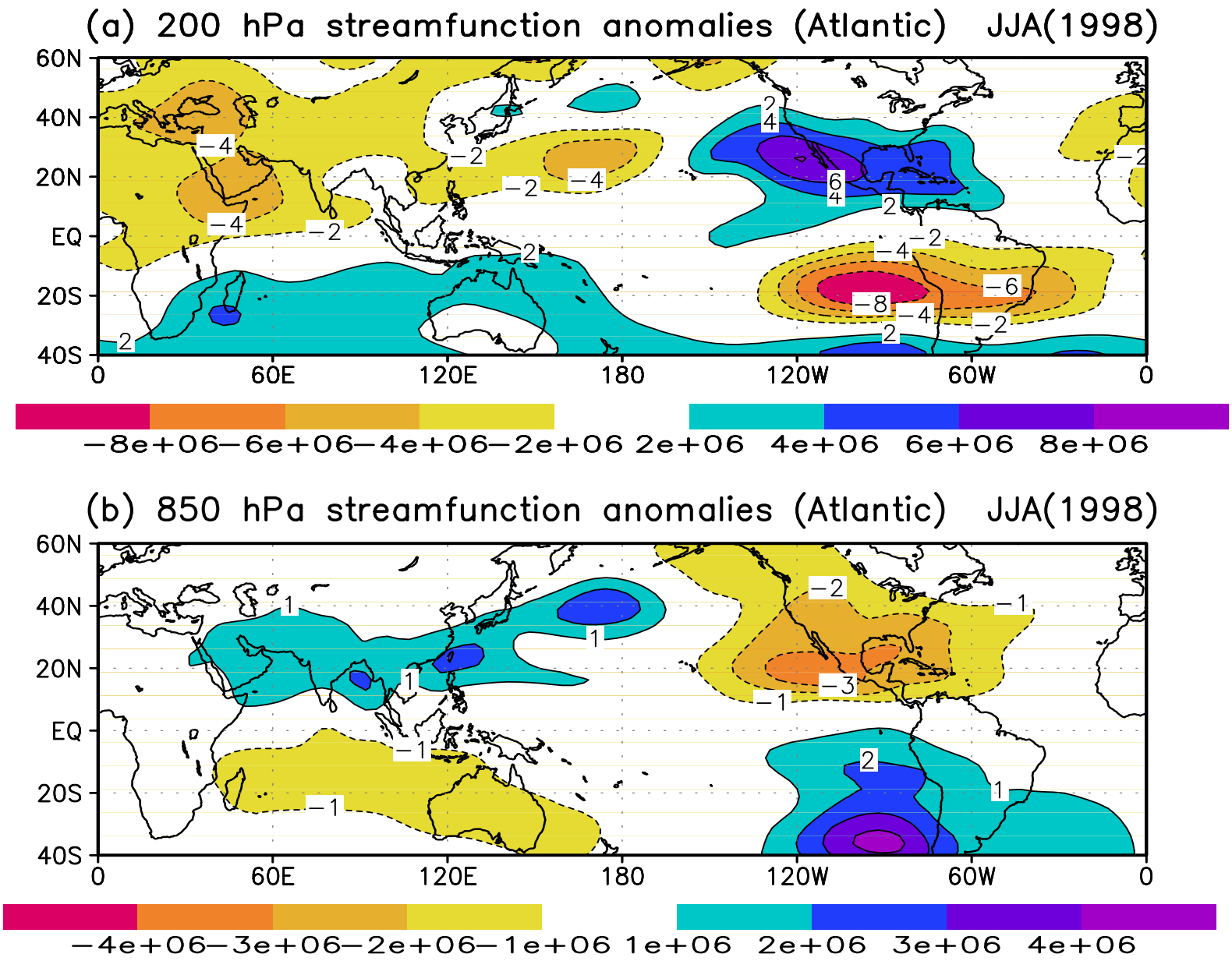

(a) 850 hPa wind anomalies (global) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(b) 850 hPa wind anomalies (without Atl.) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
(c) 850 hPa wind anomalies (Atlantic) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
10

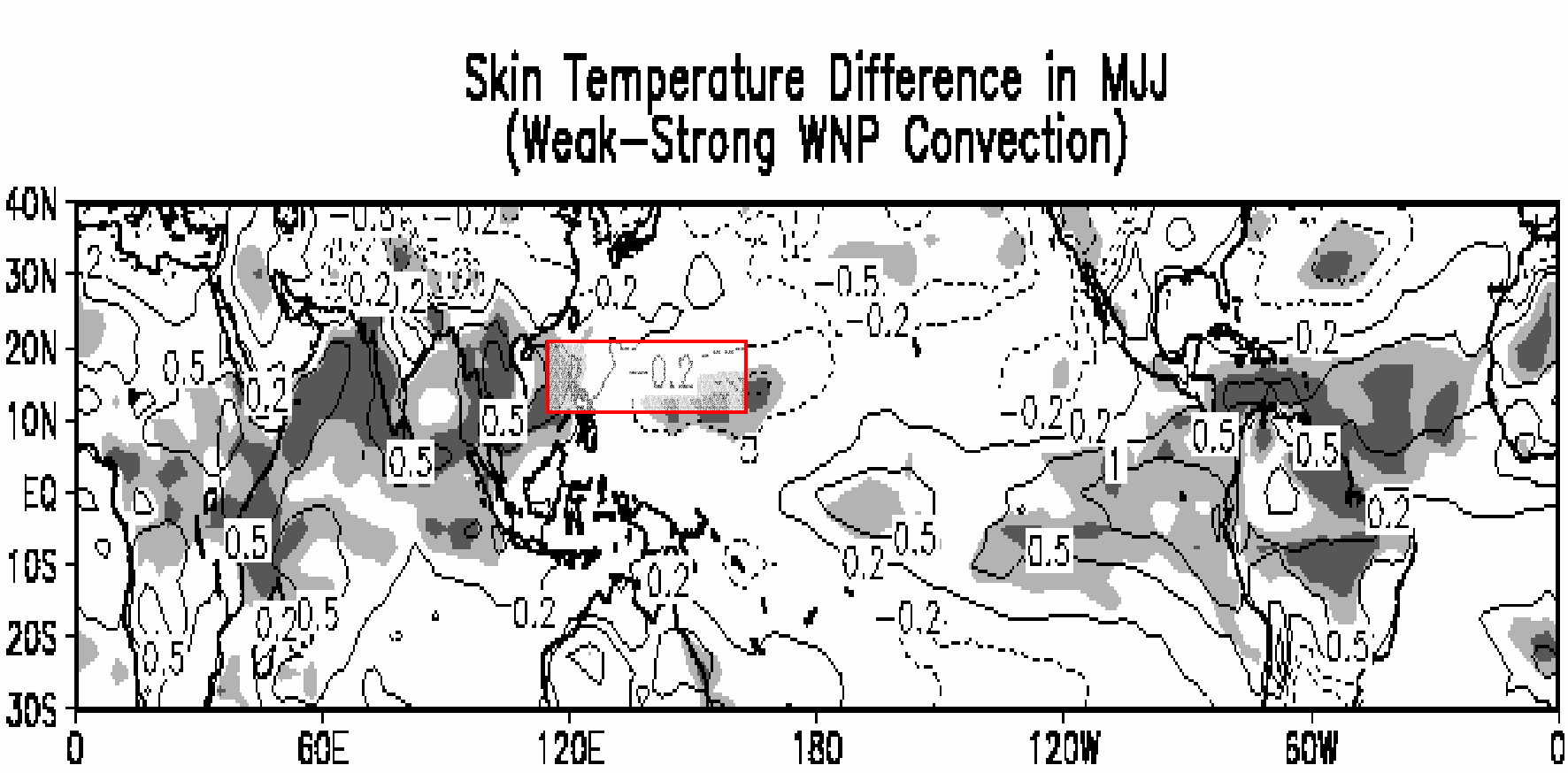
POSSIBLE MECHANISM




(c) 850 hPa wind anomalies (Atlantic) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
10


(a) 200 hPa streamfunction anomalies (Atlantic) JJA(1997)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
2
−2
−8e+06 −6e+06 −4e+06 −2e+06 2e+06 4e+06 6e+06 8e+06
(b) 850 hPa streamfunction anomalies (Atlantic) JJA(1997)
1
−4e+06 −3e+06 −2e+06 −1e+06 1e+06 2e+06 3e+06 4e+06


(a) 200 hPa streamfunction anomalies (Atlantic) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
−8e+06 −6e+06 −4e+06 −2e+06 2e+06 4e+06 6e+06 8e+06
(b) 850 hPa streamfunction anomalies (Atlantic) JJA(1998)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
−4e+06 −3e+06 −2e+06 −1e+06 1e+06 2e+06 3e+06 4e+06


Skin Temperature Difference in MJJ
(Weak−Strong WNP Convection)
40N
30N
20N
10N
EQ
10S
20S
30S
0
60E
120E
180
120W
60W
0

CONCLUSION

- The rainfall anomalies and associated circulation anomalies are well reproduced when the model is forced with the observed global SSTs in 1997 and 1998.
- The SST anomalies in the Atlantic play a comparable role as those outside the Atlantic in 1998.
- The eastward equatorial stationary wave occurs over Africa, Indian Ocean and the tropical western North Pacific, and suppresses the atmospheric convection over the latter region. The suppressed convection, in turn, influences the circulation and rainfall anomalies in East Asia.

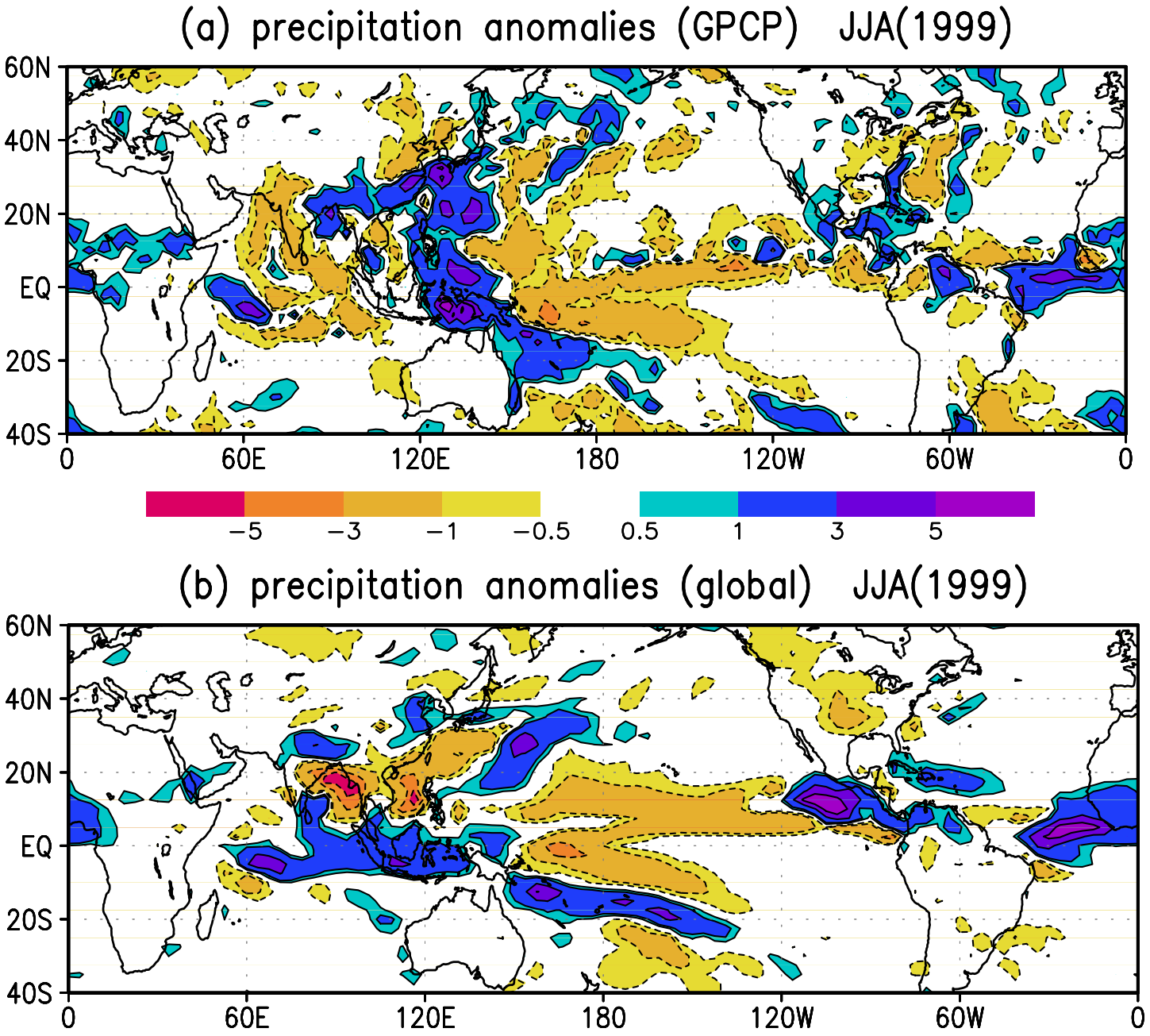
Thank you

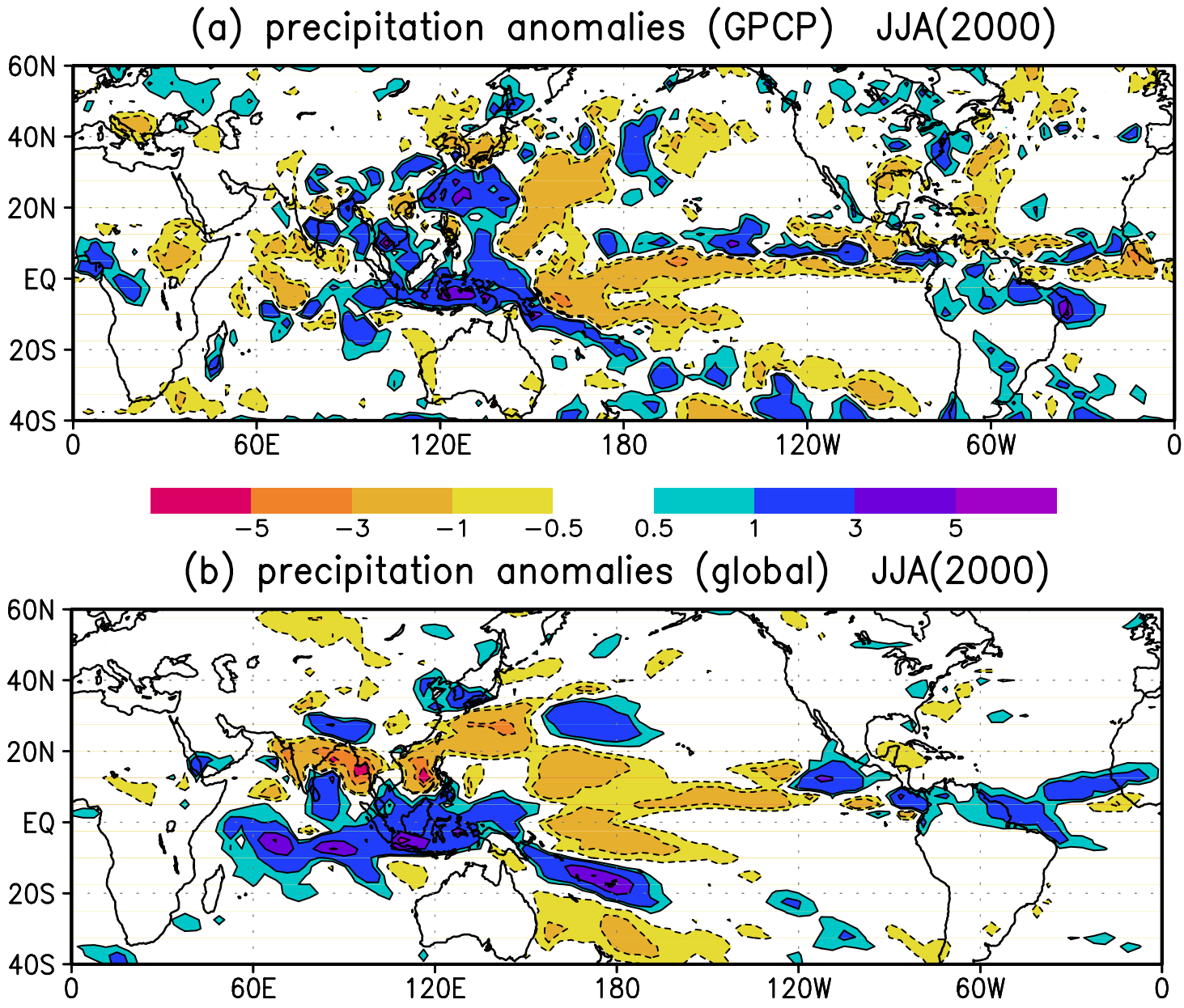
Model used

For the control integration, the spin-up was forced with climatological SSTs and lasted 1.5 years. Then the control experiment was run for 1 year beginning on December 1. For the sensitivity experiments, the spin-up was forced with observed SSTs from June 1, 1996 to December 31, 1996. Then the sensitivity experiments were integrated from January 1, 1997 to August 31, 1998.

Observational evidence

- Drought in North China in summers of 1997, 1999, and 2000
- Flood in Yangtze River Basin, South Korea, and southern Japan in summer 1998


(a) precipitation anomalies (GPCP) JJA(1999)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
−5
−3
−1
−0.5
0.5
1
3
5
(b) precipitation anomalies (global) JJA(1999)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0


(a) precipitation anomalies (GPCP) JJA(2000)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0
−5
−3
−1
−0.5
0.5
1
3
5
(b) precipitation anomalies (global) JJA(2000)
60N
40N
20N
EQ
20S
40S
0
60E
120E
180
120W
60W
0